CLAIMS

What is claimed is:

1. A method of encrypting a set of data, the method comprising:

generating an original set of data;

generating a reference set of data;

encoding the reference set of data; and

combining the original set of data with the encoded reference set of data to generate an encrypted set of data.

2. The method as set forth in Claim 1 wherein the encoding of the reference set of data comprises phase encoding the reference set of data.

3. The method as set forth in Claim 2 wherein the phase encoding of the reference set of data comprises introducing a random phase into the reference set of data.

4. The method as set forth in Claim 3 wherein the introducing of a random phase into the reference set of data comprises introducing a random phase into the reference set of data according to the equation:

$$U_R(x,y;\Delta\varphi_p) = A_R(x,y)\exp\left[i\left(\varphi_R(x,y) + \Delta\varphi_p\right)\right]$$

wherein $\varphi_R(x,y)$ is a random function, $\Delta\varphi_p$ is a phase shift between the original set of data and the reference set of data and $A_R(x,y)$ is the amplitude of the phase encoded reference set of data.

5. The method as set forth in Claim 1 wherein the encoding of the reference set of data comprises amplitude encoding the reference set of data.

6. The method as set forth in Claim 5 wherein the amplitude encoding of the reference set of data comprises introducing a random amplitude into the reference set of data.

7. The method as set forth in Claim 6 wherein the introducing of a random amplitude into the reference set of data comprises introducing a random amplitude into the reference set of data according to the equation:

$$U_R(x,y;\Delta\varphi_p) = A_R(x,y)\exp\left[i\left(\varphi_R(x,y) + \Delta\varphi_p\right)\right]$$

wherein $A_R(x,y)$ is a random function, $\Delta\varphi_p$ is a phase shift between the reference set of data and the original set of data and $\varphi_R(x,y)$ is the phase of the phase encoded reference set of data.

8. The method as set forth in Claim 1 further comprising introducing a phase shift between the original set of data and the reference set of data.

9. The method as set forth in Claim 1 further comprising recording the encrypted set of data.

10. The method as set forth in Claim 9 wherein the recording of the encrypted set of data comprises recording the encrypted set of data in a hologram.

11. The method as set forth in Claim 10 wherein the recording of the encrypted set of data in a hologram comprises recording the encrypted set of data in a hologram according to the equation:

$$\begin{aligned} I_p(x,y) = {} & [A_H(x,y)]^2 + [A_R(x,y)]^2 + \\ & 2A_H(x,y)A_R(x,y)\cos[\phi_H(x,y) - \varphi_R(x,y) - \Delta\varphi_p] \end{aligned}$$

wherein p is an integer,

$$\phi_E(x,y) = \phi_H(x,y) - \varphi_R(x,y)$$

is the encrypted phase,

$$A_E(x,y) = A_H(x,y)A_R(x,y)$$

is the encrypted amplitude, $\Delta\varphi_p$ is a phase shift between the reference set of data and the original set of data, $[A_H(x,y)]^2$ is the intensity of the original set of data and $[A_R(x,y)]^2$ is the intensity of the encoded reference set of data.

12. The method as set forth in Claim 1 wherein the original set of data comprises an optical image, a digitized image, a one dimensional set of data, a two dimensional set of data, a multi-dimensional set of data, an electrical signal or an optical signal.

13. The method as set forth in Claim 1 wherein the reference set of data comprises an optical image, a digitized image, a one dimensional set of data, a two dimensional set of data, a multi-dimensional set of data, an electrical signal or an optical signal.

14. A method of encrypting and decrypting a set of data, the method comprising:

generating an original set of data;

generating a reference set of data;

encoding the reference set of data;

combining the original set of data with the encoded reference set of data to generate an encrypted set of data; and

decrypting the encrypted set of data.

15. The method as set forth in Claim 14 wherein the encoding of the reference set of data comprises phase encoding the reference set of data.

16. The method as set forth in Claim 15 wherein the phase encoding of the reference set of data comprises introducing a random phase into the reference set of data.

17. The method as set forth in Claim 16 wherein the introducing of a random phase into the reference set of data comprises introducing a random phase into the reference set of data according to the equation:

$$U_R(x,y;\Delta\varphi_p) = A_R(x,y)\exp[i(\varphi_R(x,y) + \Delta\varphi_p)]$$

wherein $\varphi_R(x,y)$ is a random function, $\Delta\varphi_p$ is a phase shift between the original set of data and the reference set of data and $A_R(x,y)$ is the amplitude of the phase encoded reference set of data.

18. The method as set forth in Claim 14 wherein the encoding of the reference set of data comprises amplitude encoding the reference set of data.

19. The method as set forth in Claim 18 wherein the amplitude encoding of the reference set of data comprises introducing a random amplitude into the reference set of data.

20. The method as set forth in Claim 19 wherein the introducing of a random amplitude into the reference set of data comprises introducing a random amplitude into the reference set of data according to the equation:

$$U_R(x,y;\Delta\varphi_p) = A_R(x,y)\exp\left[i\left(\varphi_R(x,y) + \Delta\varphi_p\right)\right]$$

wherein $A_R(x,y)$ is a random function, $\Delta\varphi_p$ is a phase shift between the reference set of data and the original set of data and $\varphi_R(x,y)$ is the phase of the phase encoded reference set of data.

21. The method as set forth in Claim 14 further comprising introducing a phase shift between the original set of data and the reference set of data.

22. The method as set forth in Claim 14 further comprising recording the encrypted set of data.

23. The method as set forth in Claim 22 wherein the recording of the encrypted set of data comprises recording the encrypted set of data in a hologram.

24. The method as set forth in Claim 23 wherein the recording of the encrypted set of data in a hologram comprises recording the encrypted set of data in a hologram according to the equation:

$$I_p(x,y) = [A_H(x,y)]^2 + [A_R(x,y)]^2 + 2A_H(x,y)A_R(x,y)\cos[\phi_H(x,y) - \varphi_R(x,y) - \Delta\varphi_p]$$

wherein, p is an integer,

$$\phi_E(x,y) = \phi_H(x,y) - \varphi_R(x,y)$$

is the encrypted phase and

$$A_E(x,y) = A_H(x,y)A_R(x,y)$$

is the encrypted amplitude, $\Delta\varphi_p$ is a phase shift between the reference set of data and the original set of data, $[A_H(x,y)]^2$ is the intensity of the original set of data and $[A_R(x,y)]^2$ is the intensity of the encoded reference set of data.

25. The method as set forth in Claim 14 wherein the original set of data comprises an optical image, a digitized image, a one dimensional set of data, a two dimensional set of data, a multi-dimensional set of data, an electrical signal or an optical signal.

26. The method as set forth in Claim 14 wherein the reference set of data comprises an optical image, a digitized image, a one dimensional set of data, a two dimensional set of data, a multi-dimensional set of data, an electrical signal or an optical signal.

27. The method as set forth in Claim 14 wherein the decrypting of the encrypted set of data comprises generating a set of decryption keys by generating a set of intensity patterns, I'_p, of the combination of the reference beam and a phase shifted reference beam.

28. The method as set forth in Claim 27 wherein the generation of a set of decryption keys includes generating a phase key.

29. The method as set forth in Claim 28 wherein the generation of a phase key includes generating a phase key according to the equation

$$\phi_K(x,y) = \phi_C - \varphi_R(x,y)$$

wherein ϕ_C is a constant $\varphi_R(x,y)$ is a random function.

30. The method as set forth in Claim 27 wherein the generation of a set of decryption keys includes generating an amplitude key.

31. The method as set forth in Claim 30 wherein the generation of an amplitude key includes generating an amplitude key according to the equation

$$A_K(x,y) = A_C A_R(x,y)$$

wherein A_C is a constant $A_R(x,y)$ is a random function.

32. The method as set forth in Claim 29 further comprising generating a decrypted phase.

33. The method as set forth in Claim 32 wherein the generating of a decrypted phase comprises generating a decrypted phase according to the equation

$$\phi_D(x,y) = \phi_E(x,y) - \phi_K(x,y)$$

wherein $\phi_E(x,y)$ is the encrypted phase and $\phi_K(x,y)$ is the phase key.

34. The method as set forth in Claim 32 wherein the generating of a decrypted phase comprises generating a decrypted phase according to the equation

$$\phi_D(x,y) = \arctan\left[\frac{(I_4 - I_2)(I'_1 - I'_3) - (I_1 - I_3)(I'_4 - I'_2)}{(I_4 - I_2)(I'_4 - I'_2) - (I_1 - I_3)(I'_1 - I'_3)}\right]$$

wherein I_p are the encrypted set of data and I'_p are the decrypted set of data and p is an integer.

35. The method as set forth in Claim 31 further comprising generating a decrypted amplitude.

36. The method as set forth in Claim 35 wherein the generating of a decrypted amplitude comprises generating a decrypted amplitude according to the equation

$$A_D(x,y) = \begin{cases} \dfrac{A_E(x,y)}{A_K(x,y)}, & \text{if } A_K(x,y) \neq 0 \\ 0 & \text{otherwise} \end{cases}$$

wherein $A_E(x,y)$ is the encrypted amplitude and $A_K(x,y)$ is the amplitude key.

37. The method as set forth in Claim 35 wherein the generating of a decrypted amplitude comprises generating a decrypted amplitude according to the equation

$$A_D(x,y) = \left[\frac{(I_1 - I_3)^2 + (I_4 - I_2)^2}{(I'_1 - I'_3)^2 + (I'_4 - I'_2)^2}\right]^{1/2}$$

wherein I_p are the encrypted set of data and I'_p are the decrypted set of data and p is an integer.

38. The method as set forth in Claim 11 wherein said $\phi_E(x,y)$ is expressed as

$$\phi_E(x,y) = \arctan\left(\frac{I_4 - I_2}{I_1 - I_3}\right)$$

is the encrypted phase and said $A_E(x,y)$ is expressed as

$$A_E(x,y) = \frac{1}{4}\left[(I_1 - I_3)^2 + (I_4 - I_2)^2\right]^{1/2}$$

is the encrypted amplitude.

39. The method as set forth in Claim 24 wherein said $\phi_E(x,y)$ is expressed as

$$\phi_E(x,y) = \arctan\left(\frac{I_4 - I_2}{I_1 - I_3}\right)$$

is the encrypted phase and said $A_E(x,y)$ is expressed as

$$A_E(x,y) = \frac{1}{4}\left[(I_1 - I_3)^2 + (I_4 - I_2)^2\right]^{1/2}$$

is the encrypted amplitude.

40. The method as set forth on Claim 29 wherein said $\phi_K(x,y)$ is expressed as

$$\phi_K(x,y) = \arctan\left(\frac{I'_4 - I'_2}{I'_1 - I'_3}\right),$$

I'_p are the decrypted set of data and p is an integer.

41. The method as set forth in Claim 31 wherein said $A_K(x, y)$ is expressed as

$$A_K(x,y) = \frac{1}{4}\left[(I'_1 - I'_3)^2 + (I'_4 - I'_2)^2\right]^{1/2},$$

I'_p are the decrypted set of data and p is an integer.

42. The method as set forth in Claim 32 further comprising generating a decrypted hologram according to the equation

$$U_D(x,y) = A_D(x,y)\exp[i\phi_D(x,y)]$$

wherein $\phi_D(x,y)$ is the phase of the decrypted hologram.

43. The method as set forth in Claim 42 further comprising reconstructing the original set of data from the decrypted hologram.

44. The method as set forth in Claim 35 further comprising generating a decrypted hologram according to the equation

$$U_D(x,y) = A_D(x,y)\exp[i\phi_D(x,y)]$$

wherein $A_D(x,y)$ is the amplitude of the decrypted hologram.

45. The method as set forth in Claim 44 further comprising reconstructing the original set of data from the decrypted hologram.

46. The method as set forth in Claim 23 wherein the recording of the encrypted set of data in a hologram comprises recording the encrypted set of data in a digital hologram.

47. The method as set forth in Claim 46 further comprising reconstructing the original set of data from the decrypted digital hologram.

48. The method as set forth in Claim 47 wherein the reconstructing of the original set of data from the decrypted digital hologram comprises generating the discrete complex amplitude distribution of the reconstructed original set of data from the equation

$$U_O(m',n') = \exp\left[\frac{-i\pi}{\lambda d}\left(\Delta x'^2 m'^2 + \Delta y'^2 n'^2\right)\right]\sum_{m'=0}^{N_x-1}\sum_{n'=0}^{N_y-1} U_D(m,n)$$
$$\times \exp\left[\frac{-i\pi}{\lambda d}\left(\Delta x^2 m^2 + \Delta y^2 n^2\right)\right]\exp\left[-i2\pi\left(\frac{m'm}{N_x}+\frac{n'n}{N_y}\right)\right]$$

wherein $U_D\ (m,n)$ is the discrete amplitude distribution of the decrypted digital hologram, m and n are coordinates in the plane of the hologram, m' and n' are coordinates in the reconstruction plane, Δx is the horizontal resolution in the hologram plane, Δy is the vertical resolution in the hologram plane, $\Delta x'$ is the horizontal resolution in the reconstruction plane, $\Delta y'$ is vertical resolution in the reconstruction plane, N_x is the number of detector pixels in the x direction and N_y is the number of detector pixels in the y direction.

49. The method as set forth in Claim 46 further comprising reconstructing a segment of the original set of data from the decrypted digital hologram.

50. The method as set forth in Claim 49 wherein the reconstructing of a segment of the original set of data from the decrypted digital hologram comprises defining a subset, $rect\left(\frac{m-a_x}{b_x},\frac{n-a_y}{b_y}\right)$, of the decrypted digital hologram wherein a_x is x coordinate of the center of the segment of the original set of data, a_y is the y coordinate of the center of the segment of the original set of data b_x is the width of the segment of the original set of data in the x direction, b_y is the width of the segment of the original set of data in the y direction and m and n are coordinates in the plane of the hologram.

51. The method as set forth in Claim 50 further comprising defining a partial discrete amplitude distribution over the subset of the decrypted digital hologram according to the equation

$$U'_D(m,n;a_x,a_y)=U_D(m,n)rect\left(\frac{m-a_x}{b_x},\frac{n-a_y}{b_y}\right)$$

wherein $U_D(m,n)$ is the discrete amplitude distribution of the decrypted digital hologram.

52. The method as set forth in Claim 51 further comprising applying a phase factor, $\exp[i2\pi(a_x m+a_y n)]$, to the partial discrete amplitude distribution according to the equation

$$U'_D(m,n;a_x,a_y)=U_D(m,n)rect\left(\frac{m-a_x}{b_x},\frac{n-a_y}{b_y}\right)\exp[i2\pi(a_x m+a_y n)].$$

53. The method as set forth in Claim 52 further comprising generating the discrete complex amplitude distribution of the segment of the original set of data from the decrypted digital hologram according to the equation

$$U'_O(m',n';\alpha,\beta)=\exp\left[\frac{-i\pi}{\lambda d}\left(\Delta x'^2 m'^2+\Delta y'^2 n'^2\right)\right]\sum_{m'=0}^{N_x-1}\sum_{n'=0}^{N_y-1}U'_D\left(m,n;\frac{\alpha d}{\Delta x},\frac{\beta d}{\Delta y}\right)$$
$$\times\exp\left[\frac{-i\pi}{\lambda d}\left(\Delta x^2 m^2+\Delta y^2 n^2\right)\right]\exp\left[-i2\pi\left(\frac{m'm}{N_x}+\frac{n'n}{N_y}\right)\right]$$

.

54. The method as set forth in Claim 27 further comprising recording the set of decryption keys.

55. The method as set forth in Claim 54 wherein the recording of the set of decryption keys includes digitally recording the set of decryption keys.

56. The method as set forth in Claim 55 wherein the digitally recording of the set of decryption keys comprises storing the set of decryption keys in a computer-readable storage medium.

57. The method as set forth in Claim 22 wherein the recording of the encrypted set of data comprises storing the encrypted set of data in a computer-readable storage medium.

58. The method as set forth in Claim 57 further comprising transmitting the encrypted set of data to remote locations over a distributed computer network.

59. A storage medium encoded with a set of data created by:

generating an original set of data;

generating a reference set of data;

encoding the reference set of data;

combining the original set of data with the encoded reference set of data to generate an encrypted set of data; and

storing the encrypted set of data.

60. The storage medium as set forth in Claim 59 wherein the encoding of the reference set of data comprises phase encoding the reference set of data.

61. The storage medium as set forth in Claim 60 wherein the phase encoding of the reference set of data comprises introducing a random phase into the reference set of data.

62. The storage medium as set forth in Claim 61 wherein the introducing of a random phase into the reference set of data comprises introducing a random phase into the reference set of data according to the equation:

$$U_R(x,y;\Delta\varphi_p) = A_R(x,y)\exp\left[i\left(\varphi_R(x,y) + \Delta\varphi_p\right)\right]$$

wherein $\varphi_R(x,y)$ is a random function, $\Delta\varphi_p$ is a phase shift between the original set of data and the reference set of data and $A_R(x,y)$ is the amplitude of the phase encoded reference set of data.

63. The storage medium as set forth in Claim 59 wherein the encoding of the reference set of data comprises amplitude encoding the reference set of data.

64. The storage medium as set forth in Claim 63 wherein the amplitude encoding of the reference set of data comprises introducing a random amplitude into the reference set of data.

65. The storage medium as set forth in Claim 64 wherein the introducing of a random amplitude into the reference set of data comprises introducing a random amplitude into the reference set of data according to the equation:

$$U_R(x, y; \Delta\varphi_p) = A_R(x, y)\exp\left[i\left(\varphi_R(x, y) + \Delta\varphi_p\right)\right]$$

wherein $A_R(x, y)$ is a random function, $\Delta\varphi_p$ is a phase shift between the reference set of data and the original set of data and $\varphi_R(x, y)$ is the phase of the phase encoded reference set of data.

66. The storage medium as set forth in Claim 59 further comprising introducing a phase shift between the original set of data and the reference set of data.

67. The storage medium as set forth in Claim 59 further comprising recording the encrypted set of data.

68. The storage medium as set forth in Claim 67 wherein the recording of the encrypted set of data comprises recording the encrypted set of data in a hologram.

69. The storage medium as set forth in Claim 59 wherein the recording of the encrypted set of data in a hologram comprises recording the encrypted set of data in a hologram according to the equation:

$$I_p(x,y) = [A_H(x,y)]^2 + [A_R(x,y)]^2 + 2A_H(x,y)A_R(x,y)\cos[\phi_H(x,y) - \varphi_R(x,y) - \Delta\varphi_p]$$

wherein p is an integer,

$$\phi_E(x,y) = \phi_H(x,y) - \varphi_R(x,y)$$

is the encrypted phase,

$$A_E(x,y) = A_H(x,y)A_R(x,y)$$

is the encrypted amplitude, $\Delta\varphi_p$ is a phase shift between the reference set of data and the original set of data, $[A_H(x,y)]^2$ is the intensity of the original set of data and $[A_R(x,y)]^2$ is the intensity of the encoded reference set of data.

70. The storage medium as set forth in Claim 59 wherein the original set of data comprises an optical image, a digitized image, a one dimensional set of data, a two dimensional set of data, a multi-dimensional set of data, an electrical signal or an optical signal.

71. The storage medium as set forth in Claim 59 wherein the reference set of data comprises an optical image, a digitized image, a one dimensional set of data, a two dimensional set of data, a multi-dimensional set of data, an electrical signal or an optical signal.

72. A method of encrypting a set of data, the method comprising:

generating an original set of data;

generating a reference set of data;

encoding the original set of data; and

combining the encoded original set of data with the reference set of data to generate an encrypted set of data.

73. The method as set forth in Claim 72 wherein the encoding of the original set of data comprises phase encoding the original set of data.

74. The method as set forth in Claim 73 wherein the phase encoding of the original set of data comprises introducing a random phase into the original set of data.

75. The method as set forth in Claim 74 wherein the introducing of a random phase into the original set of data comprises introducing a random phase into the original set of data according to the equation:

$$U_R(x,y;\Delta\varphi_p) = A_R(x,y)\exp\left[i\left(\varphi_R(x,y) + \Delta\varphi_p\right)\right]$$

wherein $\varphi_R(x,y)$ is a random function, $\Delta\varphi_p$ is a phase shift between the original set of data and the reference set of data and $A_R(x,y)$ is the amplitude of the phase encoded original set of data.

76. The method as set forth in Claim 72 wherein the encoding of the original set of data comprises amplitude encoding the original set of data.

77. The method as set forth in Claim 76 wherein the amplitude encoding of the original set of data comprises introducing a random amplitude into the original set of data.

78. The method as set forth in Claim 77 wherein the introducing of a random amplitude into the original set of data comprises introducing a random amplitude into the original set of data according to the equation:

$$U_R(x,y;\Delta\varphi_p) = A_R(x,y)\exp[i(\varphi_R(x,y) + \Delta\varphi_p)]$$

wherein $A_R(x,y)$ is a random function, $\Delta\varphi_p$ is a phase shift between the reference set of data and the original set of data and $\varphi_R(x,y)$ is the phase of the phase encoded original set of data.

79. The method as set forth in Claim 72 further comprising introducing a phase shift between the original set of data and the reference set of data.

80. The method as set forth in Claim 72 further comprising recording the encrypted set of data.

81. The method as set forth in Claim 80 wherein the recording of the encrypted set of data comprises recording the encrypted set of data in a hologram.

82. The method as set forth in Claim 81 wherein the recording of the encrypted set of data in a hologram comprises recording the encrypted set of data in a hologram according to the equation:

$$I_p(x,y) = [A_H(x,y)]^2 + [A_R(x,y)]^2 + 2A_H(x,y)A_R(x,y)\cos[\phi_H(x,y) - \varphi_R(x,y) - \Delta\varphi_p]$$

wherein p is an integer,

$$\phi_E(x,y) = \phi_H(x,y) - \varphi_R(x,y)$$

is the encrypted phase,

$$A_E(x,y) = A_H(x,y)A_R(x,y)$$

is the encrypted amplitude, $\Delta\varphi_p$ is a phase shift between the reference set of data and the original set of data, $[A_H(x,y)]^2$ is the intensity of the original set of data and $[A_R(x,y)]^2$ is the intensity of the encoded reference set of data.

83. The method as set forth in Claim 72 wherein the original set of data comprises an optical image, a digitized image, a one dimensional set of data, a two dimensional set of data, a multi-dimensional set of data, an electrical signal or an optical signal.

84. The method as set forth in Claim 72 wherein the reference set of data comprises an optical image, a digitized image, a one dimensional set of data, a two dimensional set of data, a multi-dimensional set of data, an electrical signal or an optical signal.

85. A method of encrypting a set of data, the method comprising:

generating an original set of data;

generating a reference set of data;

encoding the original set of data;

encoding the reference set of data; and

combining the encoded original set of data with the encoded reference set of data to generate an encrypted set of data.

86. The method as set forth in Claim 85 wherein the encoding of the original set of data and encoding the reference set of data comprises phase encoding the original set of data and phase encoding the reference set of data.

87. The method as set forth in Claim 86 wherein the phase encoding of the original set of data and phase encoding the reference set of data comprises introducing a random phase into the original set of data and the reference set of data.

88. The method as set forth in Claim 10 further comprising:

processing the encrypted set of data by compression of the hologram; and

conveying the compressed hologram to remote locations over a distributed computer network.

89. The method as set forth in Claim 23 further comprising:

processing the encrypted set of data by compression of the hologram; and

conveying the compressed hologram to remote locations over a distributed computer network.

90. The method as set forth in Claim 81 further comprising:

processing the encrypted set of data by compression of the hologram; and

conveying the compressed hologram to remote locations over a distributed computer network.

91. The method as set forth in Claim 87 further comprising recording the encrypted set of data.

92. The method as set forth in Claim 91 wherein the recording of the encrypted set of data comprises recording the encrypted set of data in a hologram.

93. The method as set forth in Claim 92 further comprising:

processing the encrypted set of data by compression of the hologram;

conveying compressed hologram to remote locations over a distributed computer network.

94. The method as set forth in Claim 88 further comprising processing the compressed hologram by decompression of the hologram.

95. The method as set forth in Claim 89 further comprising processing the compressed hologram by decompression of the hologram.

96. The method as set forth in Claim 90 further comprising processing the compressed hologram by decompression of the hologram.

97. The method as set forth in Claim 93 further comprising processing the compressed hologram by decompression of the hologram.

98. An apparatus for encrypting a set of data, the apparatus comprising:

a light source for generating an optical beam;

means for dividing the optical beam into a reference beam and an object beam;

means for introducing a phase shift between the reference beam and the object beam;

means for introducing a random phase shift between the reference beam and the object beam;

a beam combiner for combining the reference beam and the object beam; and

a detector for detecting the combination of the reference beam and the object beam.

99. The apparatus as set forth in Claim 98 wherein the detector comprises a computer addressable detector.

100. The apparatus as set forth in Claim 99 wherein the detector is connected to a distributed computer network.

101. The apparatus as set forth in Claim 100 wherein the detector is connected to an electrically or optically addressable spatial light modulator.

102. The apparatus as set forth in Claim 98 wherein means for introducing a random phase shift between the reference beam and the object beam comprises a random phase mask.

103. The apparatus as set forth in Claim 98 wherein means for introducing a random phase shift between the reference beam and the object beam is positioned within the reference beam.

104. The apparatus as set forth in Claim 98 wherein means for introducing a random phase shift between the reference beam and the object beam is positioned within the object beam.

105. The apparatus as set forth in Claim 98 further comprising an object positioned within the object beam.

106. The apparatus as set forth in Claim 98 wherein the object comprises a two-dimensional or three-dimensional phase object, a color object, an original set of data comprising an optical image, a digitized image, a computer generated image, a one dimensional set of data or multi-dimensional set of data, an electrical signal or an optical signal.

107. The apparatus as set forth in Claim 98 wherein the light source is a source of infrared light.

108. The apparatus as set forth in Claim 98 further comprising a key for decrypting the encrypted set of data.

109. The apparatus as set forth in Claim 108 wherein the key for decrypting the encrypted hologram is positioned within the reference beam.

110. The apparatus as set forth in Claim 108 wherein the key for decrypting the encrypted hologram is positioned within the object beam.

111. The apparatus as set forth in Claim 98 wherein the detector is connected to a computer.

112. The apparatus as set forth in Claim 98 wherein the detector is connected to an electrically addressable spatial light modulator.

113. The method as set forth in Claim 47 wherein reconstructing the original set of data from the decrypted digital hologram comprises reconstructing the original set of data by digital image processing.

114. The method as set forth in Claim 47 wherein reconstructing the original set of data from the decrypted digital hologram comprises reconstructing the original set of data by optical image processing.

115. An apparatus for encrypting a set of data, the apparatus comprising:

a light source for generating an optical beam;

means for dividing the optical beam into a reference beam and an object beam;

means for introducing a phase shift between the reference beam and the object beam;

means for introducing a random phase shift between the reference beam and the object beam; and

a detector for detecting the combination of the reference beam and the object beam.

116. The apparatus as set forth in Claim 115 wherein the detector is connected to a computer.

117. The apparatus as set forth in Claim 115 wherein the detector is connected to an electrically addressable spatial light modulator.

118. A method of forming an image of an object, the method comprising:

forming an original hologram of the object;

compressing the original hologram of the object to form a compressed hologram;

decompressing the compressed hologram of the object to form a decompressed hologram; and

reconstructing the object from the decompressed hologram to form a multi-dimensional image of the object.

119. The method as set forth in Claim 118 wherein the forming of an original hologram of the object comprises forming a digital hologram of the object.

120. The method as set forth in Claim 119 wherein the forming of a digital hologram of the object comprises storing the digital hologram of the object.

121. The method as set forth in Claim 118 wherein the reconstructing of the object comprises reconstructing the object by digital image processing.

122. The method as set forth in Claim 118 wherein the reconstructing of the object from the decompressed hologram comprises reconstructing the object by optical image processing.

123. An apparatus for forming a remote image of an object, the apparatus comprising:

a light source for generating an optical beam;

means for dividing the optical beam into a reference beam and an object beam;

a detector for detecting the combination of the reference beam and the object beam; and

a distributed computer network connected to the detector, the network including network devices configured to execute program software allowing the devices to send, receive, record, store or process original, compressed and decompressed holograms or sets of data between and amongst themselves via the network.

124. The apparatus as set forth in Claim 123 further comprising a beam combiner for combining the reference beam and the object beam.

125. The apparatus as set forth in Claim 123 wherein the distributed computer network comprises an electrically or optically addressable spatial light modulator.

126. The apparatus as set forth in Claim 124 wherein the distributed computer network comprises an electrically or optically addressable spatial light modulator.

127. The method as set forth in Claim 118 further comprising displaying the original hologram on an electrically or optically addressable spatial light modulator.

128 The method as set forth in Claim 118 further comprising displaying the compressed hologram on an electrically or optically addressable spatial light modulator.

129. The method as set forth in Claim 118 further comprising displaying the decompressed hologram on an electrically or optically addressable spatial light modulator.

130. The method as set forth in Claim 118 wherein the reconstructing of the object from the decompressed hologram comprises optically reconstructing the object from the decompressed hologram.

131. The method as set forth in Claim 118 further comprising transmitting the compressed hologram to remote locations over a distributed computer network.

132. The method as set forth in Claim 130 wherein the optically reconstructing of the object from the decompressed hologram comprises:

displaying the decompressed hologram on a spatial light modulator; and

illuminating the spatial light modulator with a light beam.

133. A method of forming serial images of moving objects, the method comprising:

forming a series of original holograms of the moving objects;

compressing the series of original holograms of the moving objects to form a series of compressed holograms;

decompressing the series of compressed holograms to form a series of decompressed holograms; and

reconstructing the moving objects from the series of decompressed holograms to form a series of multi-dimensional images of the moving objects.

134. The method as set forth in Claim 133 wherein the forming of a series of original holograms of the moving objects comprises forming a series of digital holograms of the moving objects.

135. The method as set forth in Claim 134 wherein the forming of a series of digital holograms of the moving objects comprises storing the series of digital holograms of the moving objects.

136. The method as set forth in Claim 133 wherein the reconstructing of the moving objects comprises reconstructing the moving objects by digital image processing.

137. The method as set forth in Claim 133 wherein the reconstructing of the moving objects from the series of decompressed holograms comprises reconstructing the moving objects by optical image processing.

138. The method as set forth in Claim 133 further comprising displaying the series of original holograms on an electrically or optically addressable spatial light modulator.

139. The method as set forth in Claim 133 further comprising displaying the series of compressed holograms on an electrically or optically addressable spatial light modulator.

140. The method as set forth in Claim 133 further comprising displaying the series of decompressed holograms on an electrically or optically addressable spatial light modulator.

141. The method as set forth in Claim 133 wherein the reconstructing of the moving objects from the series of decompressed holograms comprises optically reconstructing the moving objects from the series of decompressed holograms.

142. The method as set forth in Claim 133 further comprising transmitting the series of compressed holograms to remote locations over a distributed computer network.